

A METHOD OF DETERMINING THE ALTITUDE IN THE ATMOSPHERE ABOVE SEA LEVEL WHERE THE FREEZING POINT OF WATER OCCURS

By J. F. BRENNAN, Government Meteorologist

[Kingston, Jamaica]

There are many devices already in use for registering the temperature, relative humidity, pressure, etc., aloft, such as self-registering meteorographs attached to sounding balloons, which are costly, and some delay is occasioned when recovering these instruments.

It is well known that the property of water is to expand at the instant of freezing by about 10 per cent.

Now, if a short length of copper tubing of about 0.10 inch bore with walls about 0.02 inch thick, be bent in the shape of a horseshoe, as per sketch (fig. 1), then filled with water (preferably distilled), the ends compressed in a vice and soldered, made quite free of air. At the moment of the water freezing the arms A—A will separate over half an inch. Therefore if a ring of metal wire be strung around A—A it will become disengaged at the moment of separation of the arms. A short length of thread F (about 12 inches), is secured to a paper pendant, D, and then attached to the ring B. The upper part of the horseshoe, at C, takes a length of thread, F_2 , about 10 feet, to the closed mouth of the inflated pilot balloon E. The curved portion of the copper horseshoe tube, at C, should be flattened (somewhat similar to that of a Bourdon steam gauge), so that the major diameter of the elliptic section will be double that of the transverse diameter. This flattening will, of course, aid to insure suitable separation of the arms A—A.

When all be in readiness the thread F_2 above the horseshoe should be held by the fingers, and not at F_1 , for the reason that the free-lift of the balloon is apt to permit the ring B to escape by strain.

At the moment the pilot balloon attains the altitude of freezing of water the pendant D falls away, and the altitude at this moment noted.

Mr. Brennan in his letter to the Weather Bureau adds the following:

Inclosed you will find one of the actual horseshoe copper tubes which was experimented upon, when placed in a freezing mixture of ice and salt. I have exposed quite a number, and the separation of the arms A—A upon the moment of freezing of the water had a maximum expanded space of $1\frac{1}{2}$ inches, when it fractured at the point C on the flattened curve of the tube.

The total weight of the copper tube and pendant used did not exceed 20 grams, but no doubt the device can be contrived to be much lighter if necessary.

It is just possible that much lower temperatures than 32° F. at greater altitudes may be determined by filling the tube with distilled water mixed with a small amount of glycerine, or other suitable soluble substance, whose freezing point is predetermined in the laboratory. Two or three pendants, mixed with different solutions, may be attached to a balloon, so that the temperature gradient up to great altitudes may be secured during a single pilot-balloon ascent.—*Editor*.

NOTE.—Since the receipt of Mr. Brennan's original communication he has submitted the following:

On January 30 I tried my device with two separate balloon ascents. The first failed on account of entering cloud at low altitude, and the second ascent on February 2 attained an altitude a little beyond 7,640 meters, but the pendant did not detach, whereas the freezing of water would have been met at a much lower alti-

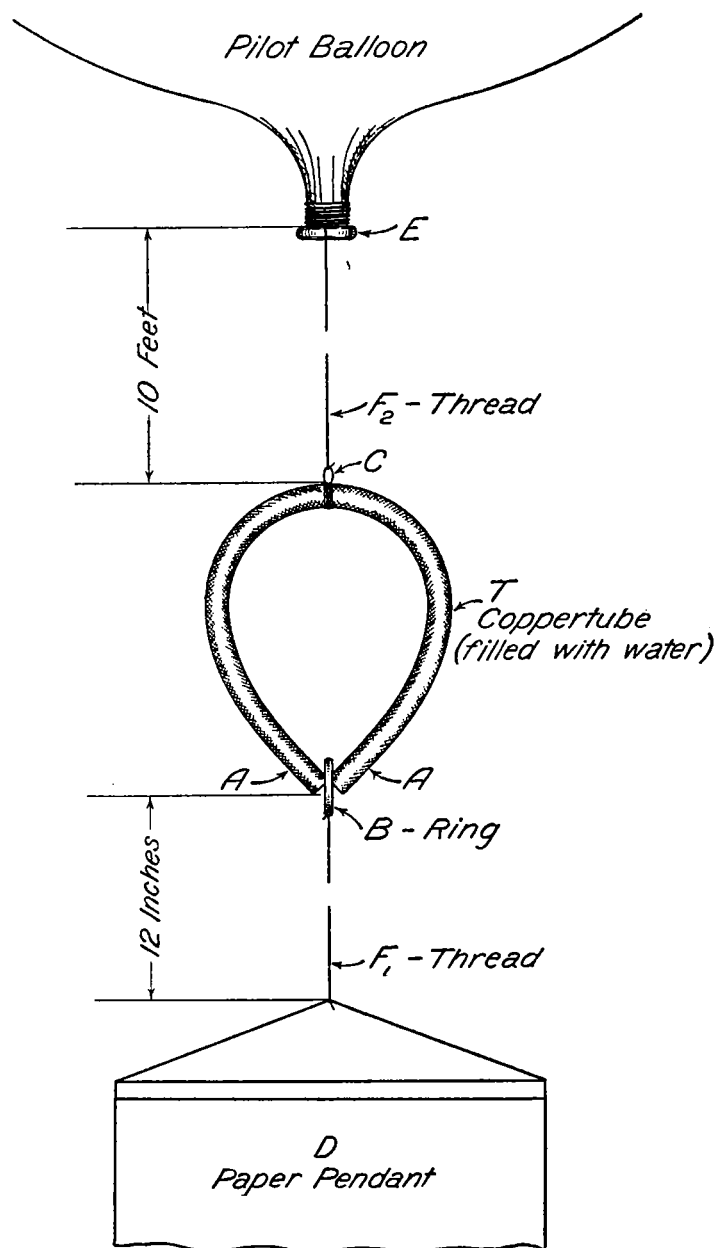


FIGURE 1

tude, in the vicinity of about 5 kilometers according to a graph on page 301, of this REVIEW 55:301, Figure 5.

In a further letter dated March 30, 1931, Mr. Brennan gives an account of placing his device in a freezing mixture in which the arms of the tube separated at 23.5° F. A second test gave a similar result. He further estimates that the pendant should release in the latitude of Jamaica at about 6 kilometers altitude.